A Malaria Type Effector in the Soybean Cyst Nematode Modulates the Plant Immune System

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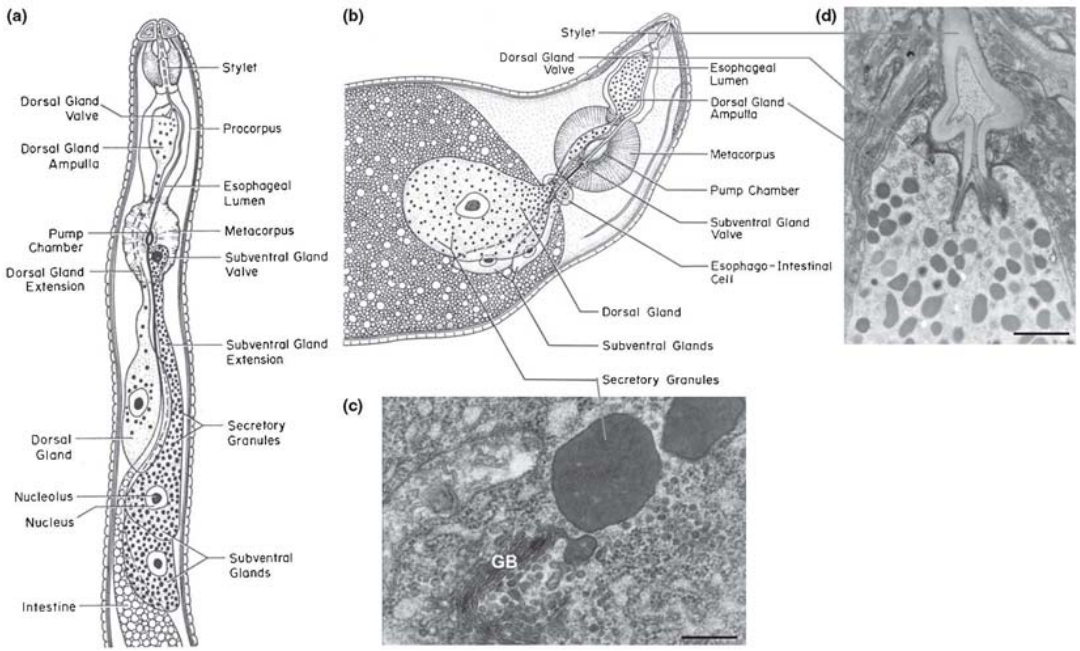
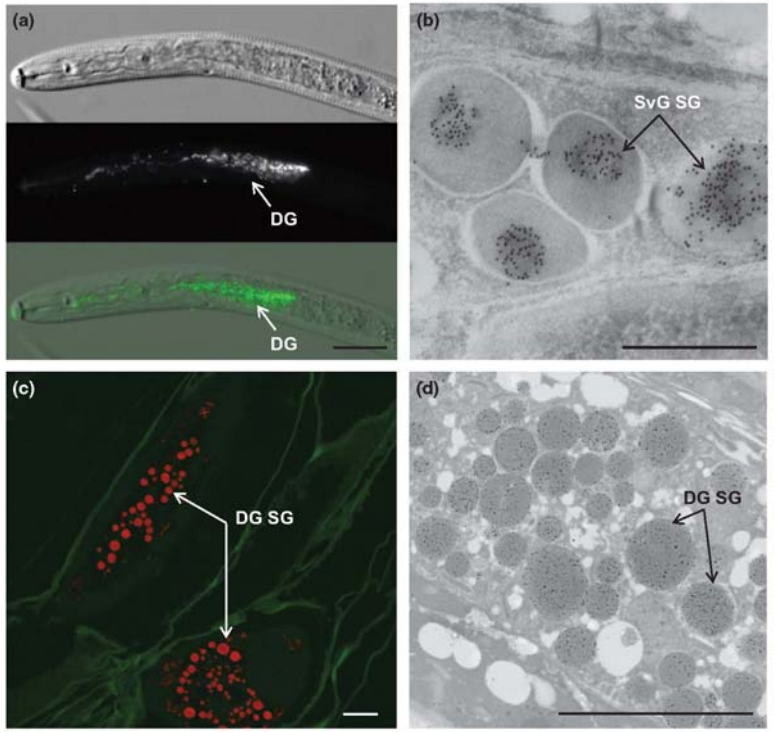
What do we study? Molecular interactions between soybean cyst nematode (SCN) and its economically important soybean host – Discover, Characterize, and Exploit (D.C.E.) for GM crop resistance

These nematodes contain secretory gland cells and a syringe-like stylet



Immunolocalization indicates secretion of proteins from the glands out of the stylet and into the plant



Mitchum et al. 2013, *New Phytologist*

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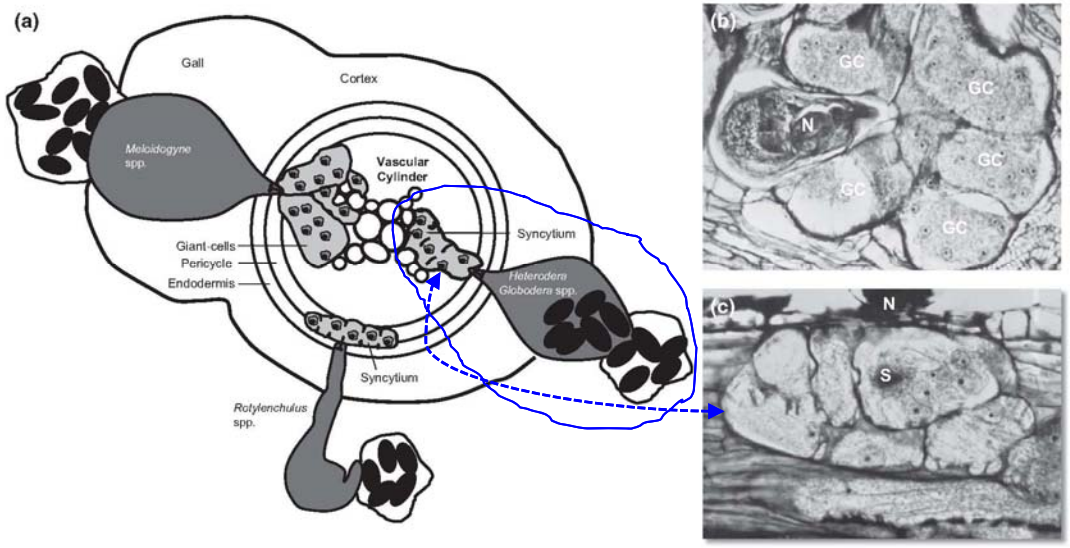
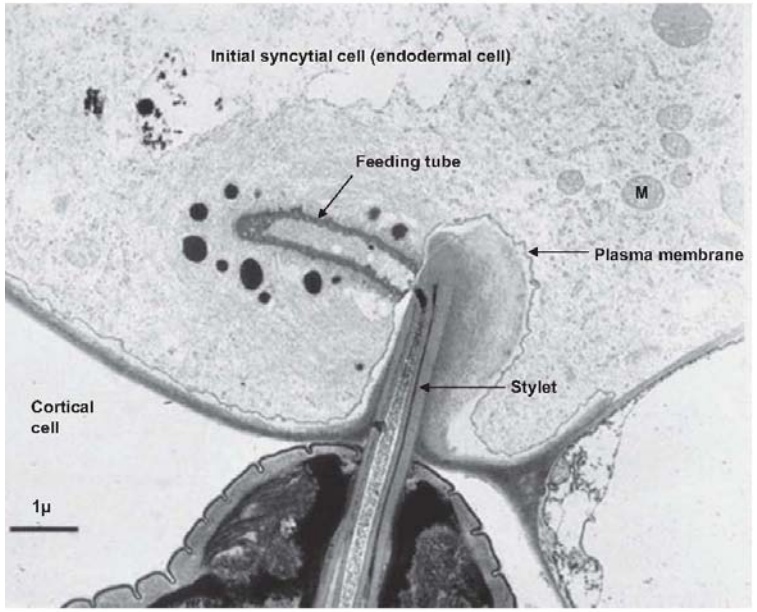
Nematode effectors directly or indirectly contribute to feeding site formation in the host root vascular cylinder



Nematodes acquire nutrients from these feeding sites to support their ~30-day life cycle



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Many SCN cysts can be identified on the roots of infested soybeans by the naked eye

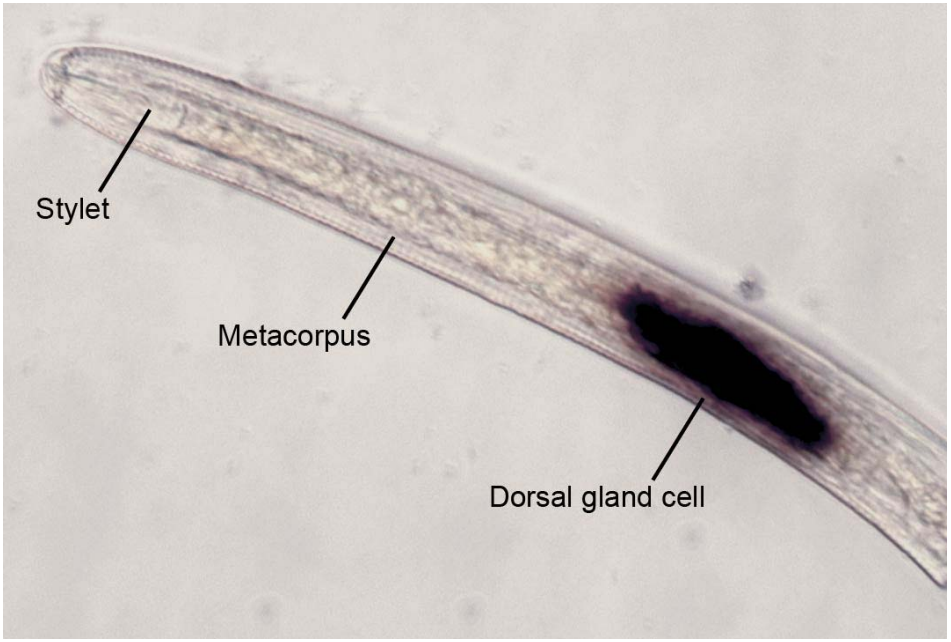
Image obtained from Purdue University Department of Agriculture

Image obtained from Corn and Soybean Digest

Major SCN infestations can lead to stunted growth and chlorosis and greatly reduced soybean yields – sectors of major infestations are common

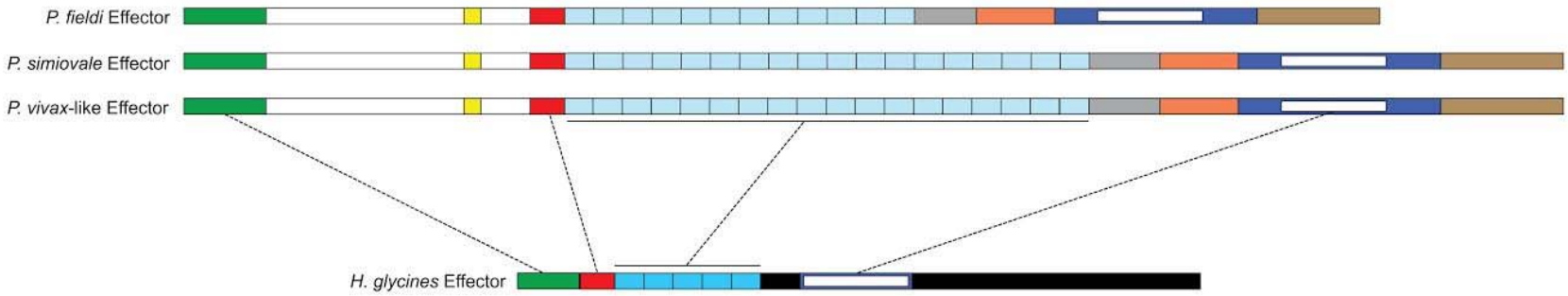
Image obtained from NuTech Seed, LLC.

A nematode effector was identified in a gland mining project for novel effectors



- Expressed strongly in the dorsal gland cell
- Expressed throughout the entire life cycle of the nematode
- The protein sequence contains a single peptide for secretion

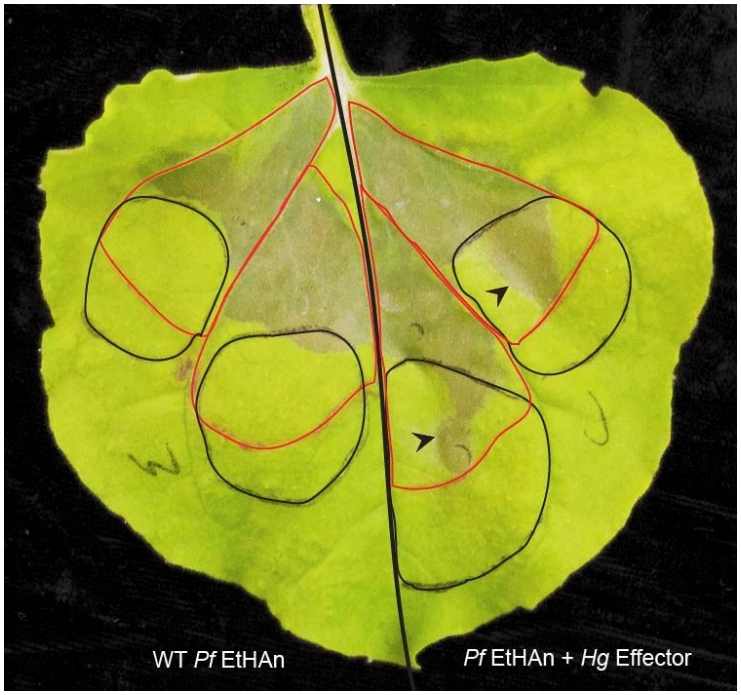
We found 3 functional domains in the nematode effector only found in an effector of the malaria parasites



- The malaria effector suppresses the human and animal immune system.
- The domains in the nematode effector are only those that function in suppressing the immune system.
- We hypothesize that the nematode effector similarly suppresses the plant immune system.

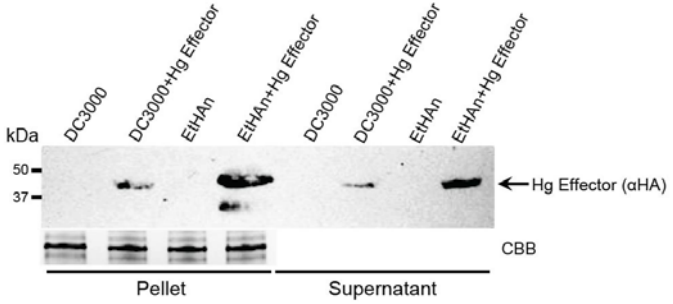
The nematode effector suppresses Pattern and Effector-Triggered Immunity (PTI & ETI) in tobacco against *a* non-pathogenic and pathogenic bacterium, respectively

The nematode effector suppresses PTI.



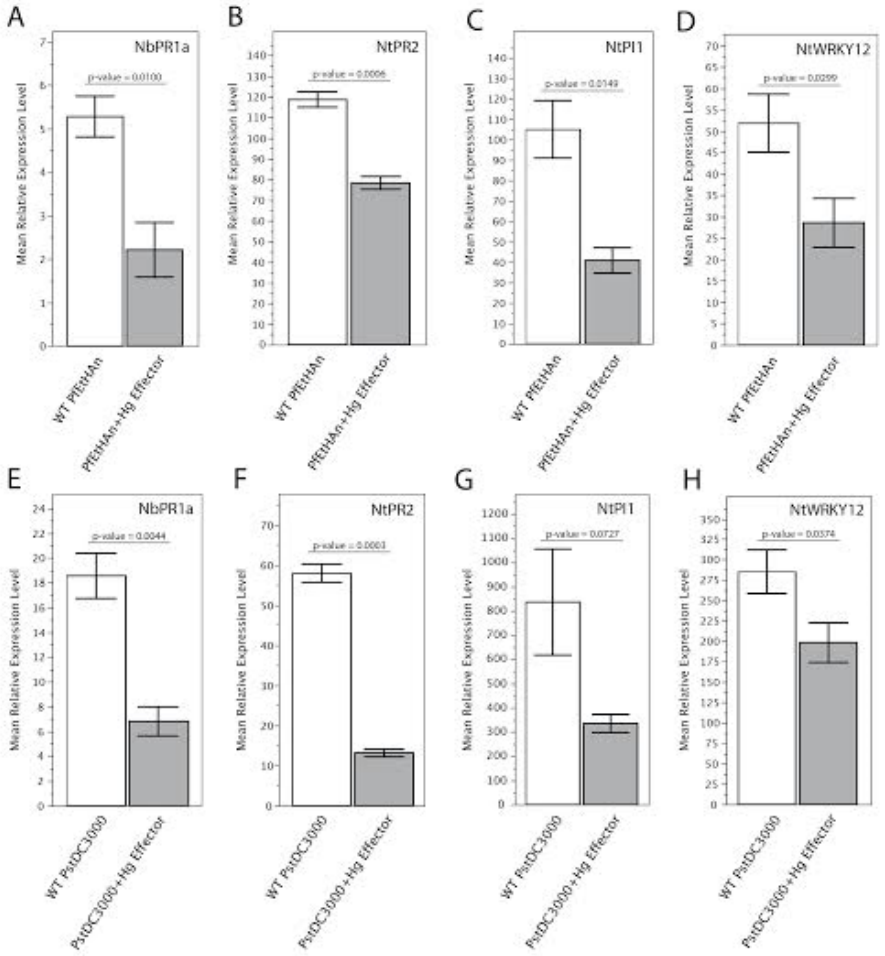
The nematode effector suppresses ETI.

Western blots indicate that the nematode effector is secreted from the bacteria.

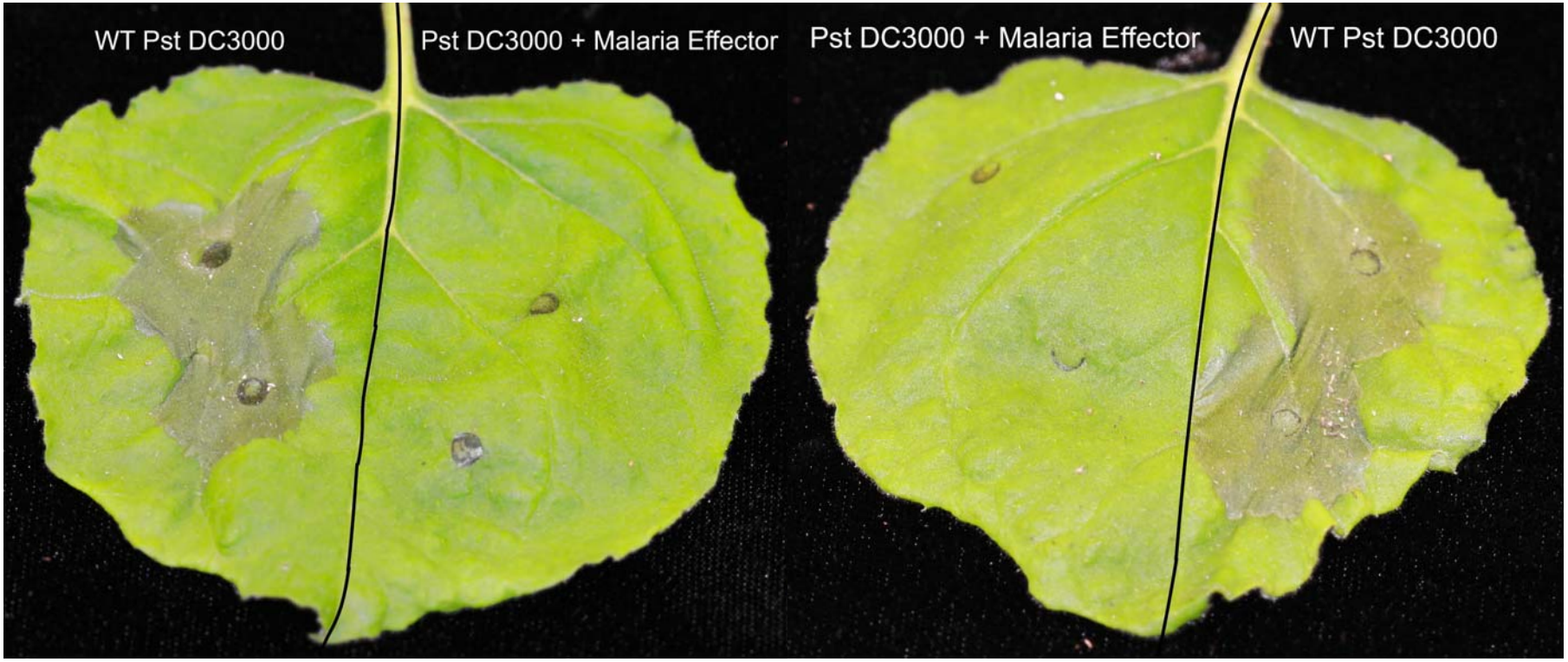


The nematode effector suppresses the induction of marker genes associated with plant immunity

- Four marker genes are highly expressed when the immune system is activated
- The nematode effector suppresses the induction of all four marker genes in both PTI and ETI

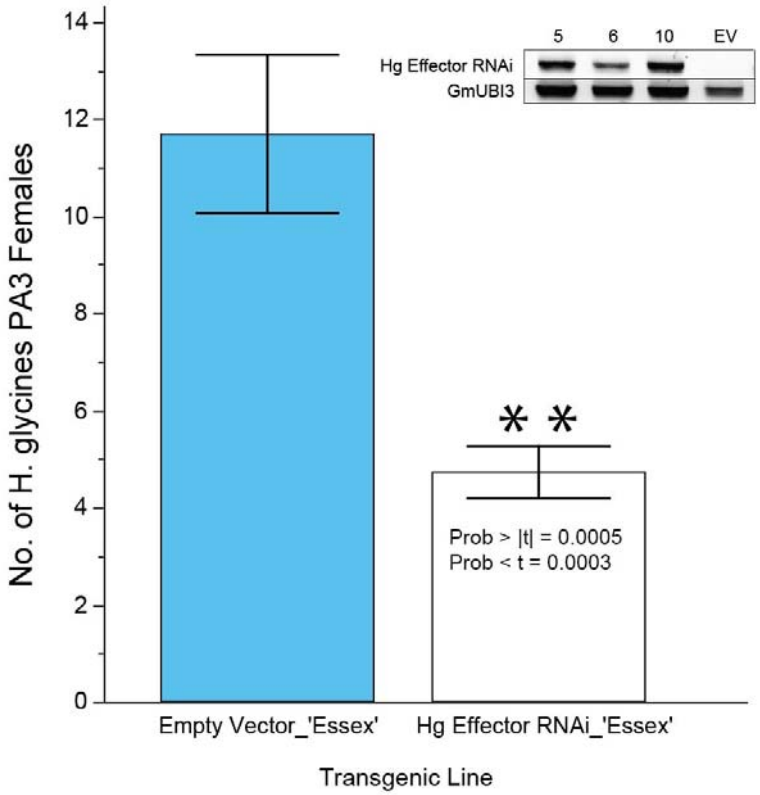


Similar to the nematode effector, the malaria effector also suppresses the plant immune system

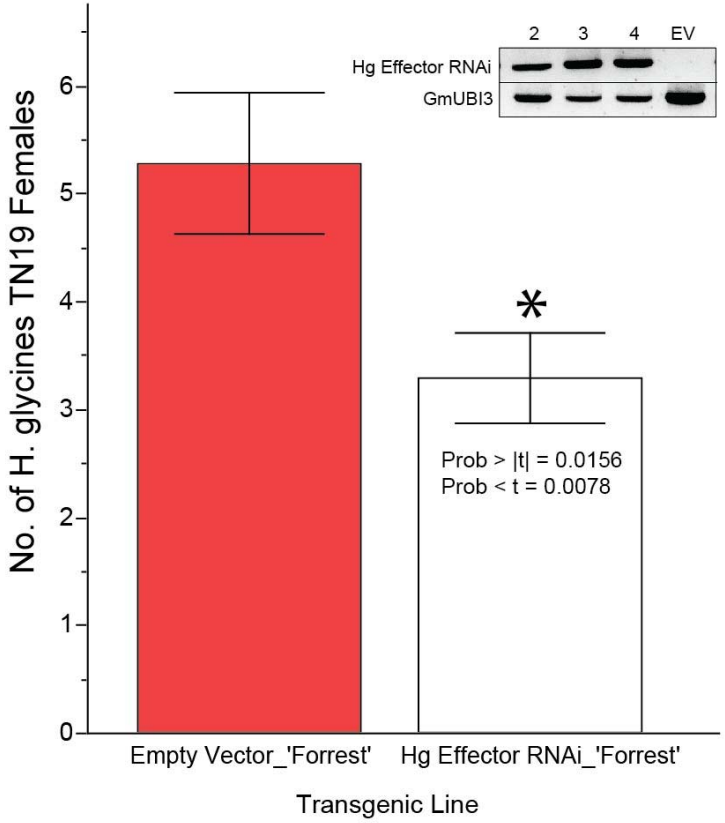


ETI was suppressed in 100% of tobacco plants tested when the pathogenic bacteria contained the malaria effector.

RNAi (RNA interference) against the nematode effector resulted in significantly reduced susceptibility of soybean to the nematode



Susceptible soybean cultivar infected with avirulent nematode



Resistant soybean cultivar infected with virulent nematode

Conclusions

- The nematode effector is necessary for full parasitic ability of soybean.
- The nematode and malaria effectors appear to suppress the immune systems of plants and animals, respectively, using similar mechanisms.
- We hypothesize that these similarities are due to either convergent evolution or horizontal gene transfer.

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